THE NITRATE INDUSTRY

ENRIQUE CUEVAS

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By Señor Enrique Cuevas

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INTRODUCTORY NOTE BY THE PUBLISHER

Since the outbreak of the European war, resulting in the destruction of much shipping, the need of promoting an effective Entente Cordiale between the countries of South America and those of North America has been strongly emphasized.

It has been especially gratifying, therefore, to witness a second Pan-American Congress called in Washington for the promotion of such an Entente with Latin-America.

The temporary closing of the Panama Canal, after merchants had come to know its great convenience so well, further disclosed the vital need of promoting transportation between the two Continents. It is not by any means necessary to confine it to water transportation. Water freights for Nitrate of Soda have been as high as thirty dollars ($30.00) a ton of late, and this would be less by all rail, were such facilities in existence.

The completion of the Longitudinal Railway of the American Continent is greatly to be desired. With such a railway, North America need not be cut off from the indispensable Chilean Nitrate of Soda as a munition of war in time of need. On the other hand, the transportation of all necessities, at all times, to the South American Countries would render all rail route between Kansas City and Buenos Aires of inestimable value.

As is well-known by all scientific men who have approached the subject with an open mind, the Nitrate supplies of Chile are for all practical purposes inexhaustible.

The Central Empires of Europe imported from Chile in the five years ended December 31, 1914, an unheard of tonnage of Nitrate of Soda amounting to about five million (5,000,000) tons. The area of the Central Empires is hardly greater than the combined areas of California and Texas. These Empires imported more than all the rest of Europe for the period named.

It is not improbable that a very great amount of this five million (5,000,000) tons is still held in reserve in Germany, and it is privately reported that no Chilean Nitrate is to be permitted to be used in agriculture for some time to come.

It is believed that the views set forth by some experts at the Pan-American Congress, suggesting our entire independence of this most important South American product, should not be taken too seriously, and it may prove so later when subjected to the cold, dry light of hard-headed business experience. These views, therefore, while animated and most interesting, did not touch upon the eminently desirable proposal of Señor Cuevas, which is entirely within the sphere of practical things.

It is strongly urged that his able Address be read by North Americans from the standpoint of friendly presentation of the broad views of a statesman.

It is, in effect, an invitation to trade with them and not a proposal for us merely to buy or for South Americans merely to sell, but rather that ladings may be always full in both directions.

Our merchants and manufacturers have a very keen desire to sell their goods to South America, which is a new market; and Pan-Americanism points to trade development that will enable South Americans to sell goods to North Americans, as well as to buy them from us.

It still remains for diplomatic expressions of good will to be translated into terms of practical trade reciprocity, which is to be of mutual advantage to the people of both Continents.

Should the States of North America enter the field of manufacturing Air Nitrate, Chile might add a plant for direct competition by water power since that is quite adequate in that country for large production.

It is a great pleasure indeed to be able to reproduce the views expressed so vividly by Counselor Cuevas of the Chilean Embassy at Washington, in his description of the Chilean Nitrate Industry in the succeeding pages.

His high position with his government and his long experience in that service as Governor of one of the large provinces of Chile, guarantee a sincerity of expression which, it is believed, will be fully appreciated in the perusal of his Address.

NEW YORK, *April,* 1916.

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The Nitrate Industry

By

Enrique Cuevas.

General Remarks.

In the great desert of Northern Chile lies an area of over 450 miles in length, barren and desolate, bereft of trees, shrubs or even weeds. Yet, it is the one spot upon which the world is dependent for its supply of the most effective means of increasing the productiveness of its soil, for along this arid region stretch the vast deposits of the precious mineral, from whose exports alone the Government derives an annual revenue of over $35,000,000 U. S. Currency.

For the benefit of those who are not acquainted with the origin and preparation of nitrate, it may not be amiss to say a few words on this point. Owing to the fact that the nitrate industry is carried on in no other country than Chile, many of the technical words used in connection therewith have no exact equivalent in other languages, and it thus becomes necessary to explain the meaning of such terms as will be employed in the course of this discussion.

The area in reference is commonly known as the *Pampa Salitrera* — the nitrate plain— where lie the deposits of *caliche,* the raw material from which saltpeter is extracted. This salt contains nitrate of sodium in the proportion of 95 per cent, the commercial standard.

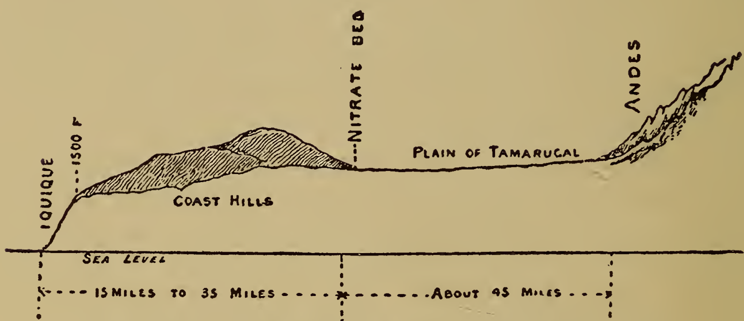
Chuca, costra and *tapa* are the layers found above the *caliche,* while those lying below are called *conjelo* and *coba.*

The survey for locating *caliche* beds and determining the quantity and standard of the material is known as *cateo.*

Oficinas salitreras is the name applied to the various establishments which operate the deposits and prepare

the finished product for the market. They are scattered throughout the *Pampa* like small cosmopolitan towns, inhabited by Chileans and people of different nationalities. Each *oficina* stands in the midst of the field from which its *caliche* is obtained. It is a group of buildings equipped with modern machinery, chemical laboratories, crushers, boiling tanks, settling vans, offices, and living quarters. An important part of this group, which should be mentioned in passing, though one subordinate to the main object of securing as much nitrate as possible, is designed for the extraction and preparation of iodine from the mother lye.

The nitrate zone is situated at an altitude ranging between 2,000 and 5,000 feet above sea level, within



GENERAL EAST AND WEST SECTION OF THE NITRATE DISTRICT OF CHILI.
VERTICAL SCALE EXAGGERATED.

19° 11′ and 27° South latitude. In the north it is separated from the coast by a distance of about 16 miles, and by nearly 90 miles in the south. It is connected with the shore by a number of railway lines. The climate prevailing is a peculiarly dry one, there being hardly any precipitation. However, it is to this lack of rainfall that the nitrate beds owe their very existence, as the water filtering into them would naturally dissolve their components.

History of Nitrate.

The history of nitrate may be divided into three distinct phases, to wit: (1) History of the discovery of the substance; (2) history of the methods of prepara-

tion, and (3) history of the manner of acquiring the lands.

History of the Discovery of Nitrate.

According to tradition, the first discoveries of *caliche* were made in Tarapaca by the Indians, and it was first applied as a fertilizer by a priest at the head of a parish in Camina.

It is said that a party of Indians had straggled into what is known to-day as the *Pampa Salitrera,* and, as a protection against the intense cold, they built themselves a bon-fire. To their amazement, they noticed that the fire soon began to run along the ground in every direction, causing what to them were strange and unaccountable noises. Terrified at so unusual a sight they fled from the spot, which they firmly believed to be the abode of the èvil spirit. The flames, spreading out sometimes to quite a distance from the original fire, were to their minds the evil spirit itself. So they went to the priest and told him of their terror and its cause. He quickly understood that the phenomenon was simply due to the existence of some special substance in the soil, and asked the Indians to take him to the place. They readily agreed, believing the priest possessed with the power of banishing the evil spirit, and an expedition was organized. He gathered many specimens, which he took to his house, and, with the meagre chemical outfit at his disposal, made an analysis of these samples, which showed the presence of nitrate of soda.

The samples which had not been used in the analysis, he piled up in his garden, and a few days later he noticed an extraordinary development in the plants which happened to be near the piles. Convinced that he had discovered a powerful tonic for plants, he undertook to experiment with it on his crops, finding after the first year that the products were much larger and far superior to those he had obtained in his previous agricultural experience.

Then the priest announced to his parishioners that the soil was not the abode of the evil spirit, but a gift of Providence for increasing the productiveness of the earth. So much for tradition.

Official documents of the time of Philip the Fifth show that saltpeter was then already known. In the 18th Century, the mines of Huantajaya and others were extensively exploited, and the miners used the *caliche* in the preparation of the gunpowder which they used in working their mines.

History of the Manufacture of Nitrate.

Tarapaca was the cradle of the nitrate industry. The Indians used to prepare the substance, for gunpowder purposes, in large copper caldrons. The working process was very simple. The *caliche* was placed in these caldrons when the water had reached the boiling point. The solution was finally transferred to large wooden vats where the nitrate finally crystallized. This method was in use until the beginning of the 19th Century, when a more scientific process of dissolution was adopted.

The first *oficinas* were established in 1812. Wood was still used as fuel and the working implements differed very little from those used by the Indians. The process of manufacture, however, varied somewhat. The Indians used to boil the water first; the *caliche* was then put in and the solution stirred for some time with large iron bars. Then the water was taken out of the caldrons with huge iron spoons and put into the wooden vats for its decantation; the solution was afterwards transferred to other vats in which it finally crystallized. There was no specially adapted machinery for extracting the *caliche* and carrying it to the working plant.

It may be readily seen that under this method only a very small part of the *caliche* extracted was finally prepared, the greater portion being lost in the process. Owing to imperfect ways and means, a large quantity was lost in the extraction, as the water did not dissolve a large percentage of the nitrate in the *caliche,* and a great portion of the solution leaked through the wooden vats.

About 1855, a new era was inaugurated for the nitrate industry with the introduction of steam as a means of heating the water for the solution. At first, the steam was applied directly, being forced into the water. Twenty years later the use of steam in coils was adopted, the same principles governing the Shanks system for

the production of soda being applied to the manufacture of nitrate. This system is very successful in the working of the *caliches* of Tarapaca, which are soft and porous, and at present the same methods, more or less modified, are employed in the different *oficinas*.

History of the Acquisition of Lands.

Until the year 1868, the nitrate fields, like other mineral lands, were unclaimed. Almost anybody could for the asking secure from the government a grant of two *estacas*, an *estaca* comprising about 36,000 square yards.

The method of surveying the boundaries of lots was a very imperfect one. A justice of the peace attended to the conveyance of the property. The instruments used were a compass and a rope about 45 yards long. The surface was marked off by lines traced on the ground by means of a hammer dragged at the end of the rope. Small piles of stones were then placed at the intersections of such lines, and at right angles therewith small stones were laid just far enough to show the direction of the dividing lines. This was the official basis for deeding the property, and, as one can easily imagine, the position of these markings could be changed without much trouble whenever the owner found out that the standard of the *caliche* in his grant was not high enough.

The regulations in force at that time prescribed no other limitations than that of restricting nitrate grants to two *estacas* per person; consequently it was an easy matter for a large family, for instance, to form an extensive holding by joining the lots of its different members.

In January, 1873, the Peruvian Government assumed the monopoly of the nitrate industry, and fixed the export duty on the article at 4 cents per *quintal* (1 Spanish quintal being equal to 101.44 pounds), increasing it later to 15 cents. In 1875, the Peruvian Congress passed a law of eminent domain authorizing the Government to spend the amount of 7,000,000 pounds sterling in the condemnation of *oficinas salitreras* and in the construction of nitrate railways. In 1876 it was enacted that in July of the following year the *oficinas* should be turned over to the government and that their operation should cease.

Under the law, commissions of engineers were appointed to ascertain the value of grants and *oficinas* to be purchased by the Government. Nevertheless, the method of procedure followed by these commissions was inadequate. In the main, they trusted altogether to the data furnished them by the proprietors, and, without verifying the actual limits of the property, gave out certificates to the owners. From this arose the difficulty encountered by the Chilean Government after the Pacific War,— which left Chile in possession of the nitrate zone,— in turning over the property to the holders of the certificates. At present, most of the titles have been cleared up, and lands owned by the Government are sold from time to time at public auction and accurately surveyed.

Origin of the Deposits.

This is a mooted question on which no two geologists agree. There are, however, some theories which are generally accepted as more or less correct. One is that in prehistoric times, the entire nitrate zone was a part of the Pacific Ocean, and that through volcanic disturbances that portion of the sea was cut off and the water evaporated by a very slow process. Fish skeletons found in the *caliche* furnish good proof of this assertion, as does the fact that the Pacific coast is rising gradually. This theory is, however, contradicted by the fact that no bromine exists there,— a substance naturally looked for in deposits thus formed.

Another theory attributes the origin of the *caliche* to an electrical process. The passage of an electric spark through the moist air produces a combination of nitrogen and oxygen resulting in nitric acid. Electrical storms,— a frequent occurrence in the Andes,— may have acted in this way and formed great quantities of nitric acid. The water charged with the acid, coming into contact with the lime in the rocks, may have produced nitrate of lime, which together with sulphate of soda, may in turn have formed nitrate of soda, freeing the sulphate of lime.

A later theory maintains that the deposits are an

accumulation of land drainage brought down through ages from the highlands along the coast.

Others explain the formation as the work of microbes, or as the result of the action of volcanoes discharging through their craters ammonia-charged steam there condensed.

Leaving the solution of the problem to geologists, we may now proceed with a consideration of the substance as found on the spot.

Nitrate as it is Found.

Nitrate is found mixed with other substances in irregular sections of the soil, forming a stratum frequently interrupted by sterile sections. It is generally considered that no more *caliche* is found below the *coba,* but in some cases there is a second nitrate-bearing layer, called *banco.*

The *chuca,* the layer with which the nitrate field is always covered, is usually not over ten inches thick, and is formed by the decomposition of porphyry, its color varying from gray to brown. In this layer many loose crusts and rough pieces of a gray-white color are found embedded.

The *costra,* the layer beneath the *chuca,* is a sort of rocky conglomeration of clay, gravel, porphyry and feldspar, cemented together with sulphate of calcium, sulphate of potash and soda, nitrate of soda, etc. This is a very hard mass, and is difficult to remove without the aid of explosives.

The *tapa* is the layer found immediately above the *caliche* and is composed of sand and clay, common salt and sulphate of calcium. The *costra* and *tapa* have a depth of from one to three feet.

The *caliche* stratum, with a depth varying from a few inches to six or more feet, is a mixture of which there are technically three different grades: (1) the best, containing from 40 to 70 per cent or more of nitrate; (2) the medium, containing from 30 to 40 per cent; and (3) the lower, containing from 18 to 30 per cent. *Caliche* averaging below 17 per cent is not considered worth working at present.

The appearance and composition of *caliche* differ in

the various zones. It is often white as snow; in other instances it is yellow, gray, or sometimes violet. It has a salty taste, and is very soluble in water.

The standard of nitrate of sodium in the fields under exploitation varies from 18 to 70 per cent, the average being from 20 to 50 per cent. The *caliches* of higher standard are found in Tarapaca and Tocopilla.

The substances of which the *caliche* is composed, and the proportions in which they are found, vary a great deal. One of the numerous analyses we have examined gives the following composition:

	Per cent.
Nitrate of sodium	34.2
Common salt	32.0
Insoluble matters (clay, gravel, etc.)	14.5
Sodium sulphate	8.4
Calcium sulphate	6.3
Nitrate of potassium	1.6
Magnesium sulphate	2.0
Water	1.0
	100.0

The *conjelo,* the layer immediately below the *caliche,* is composed of sand, different salts, and clay, and very often a great quantity of small selenite crystals.

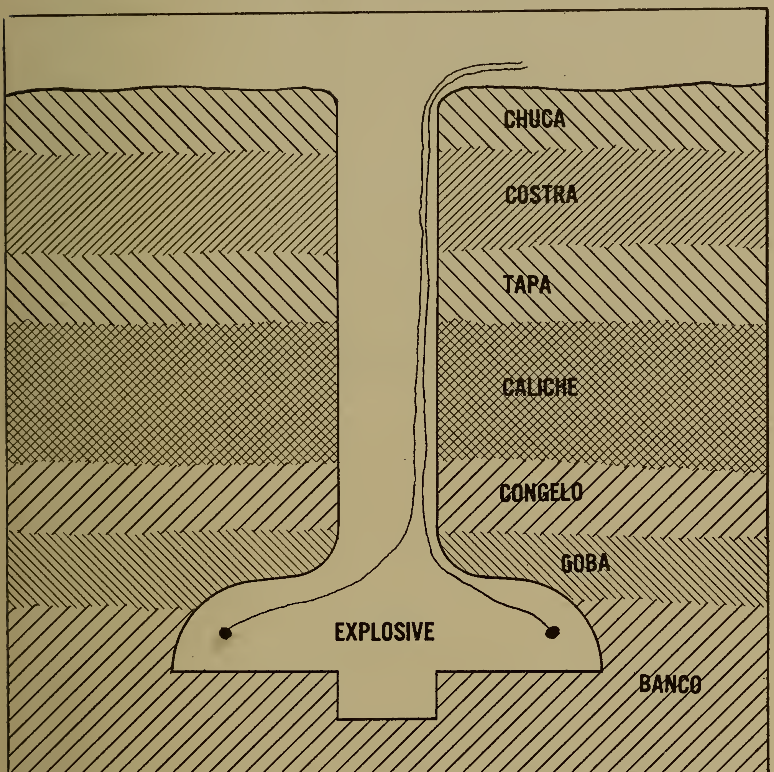
The *coba,* the stratum under the *conjelo,* moist as a general rule, is formed of calcium sulphate, clay, etc.

Cateos.

This operation consists of ascertaining the existence of the *caliche,* the depth of the strata lying over it, the standard of the material, etc. This is done by blasting at certain depths and regular distances. It is not difficult, when the ground is thus broken, to determine the width of the vein, to compute the degree of difficulty in its extraction, by taking its depth into account, and to ascertain the average standard by making an analysis of the *caliche* in the different places. So, by means of this process, it is practicable to estimate with more or less accuracy, the quantity of nitrate in the soil under

cateo. The quantity thus determined is called the theoretical quantity. The amount of nitrate that can actually be exploited is obtained by subtracting from this figure the *caliche* of a low standard.

The commercial price of a *salitrera* depends, of course, upon the standard of the *caliche,* the depth of the veins, the amount of the water available for the working



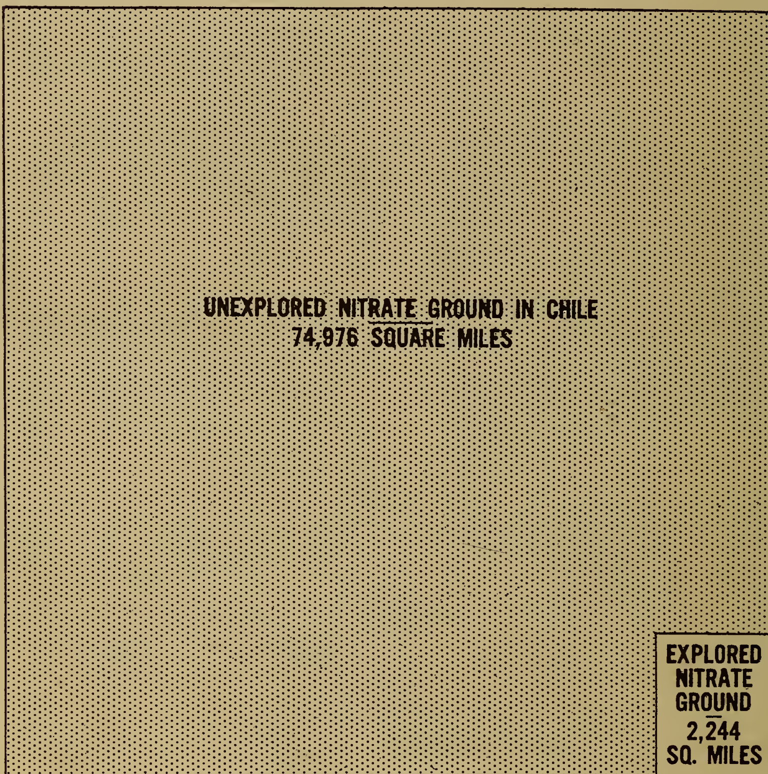
process, and the location of the fields, i. e., distance from the shipping port and transportation facilities thereto.

Extent of Nitrate Deposits in Chile.

According to the latest official report presented to the Chilean Government by Mr. Francisco J. Castillo, the Inspector-General of the nitrate deposits, the zone

of nitrate-bearing grounds comprises nearly 200,000 square kilometers,* of which only 5,811 square kilometers, that is to say, less than three per cent of the total area, have thus far been surveyed and their contents ascertained by excavations and test holes.

These 5,811 square kilometers belong to the existing companies, private firms, and part of them are still in the hands of the Chilean Government.

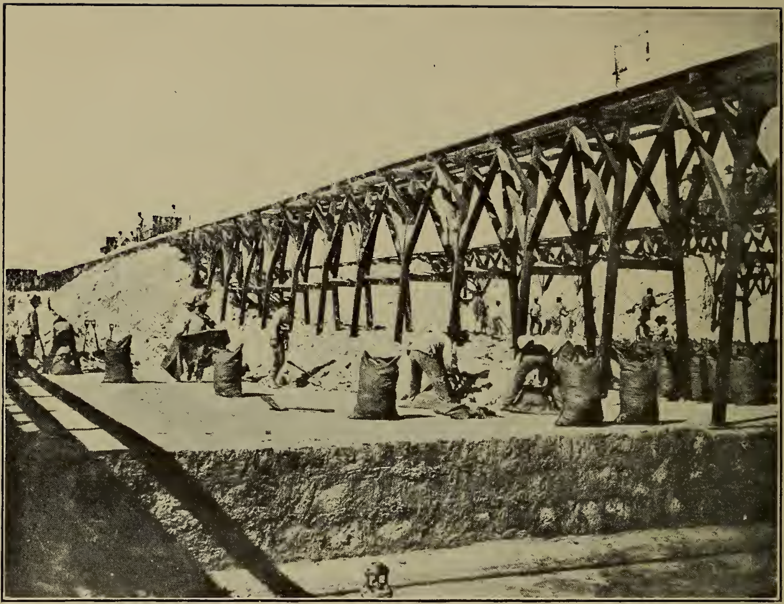


The estimated contents of these 5,811 square kilometers were 290,300,000 tons of nitrate, of which up to the present 50,000,000 tons have been extracted and exported, leaving in the surveyed portion of the area, 240,300,000 tons of nitrate, equal at the present rate of production, to a supply for an additional 100 years.

* 1 square kilometer = 0.386 square mile.

Caliche ready for transport to oficina.

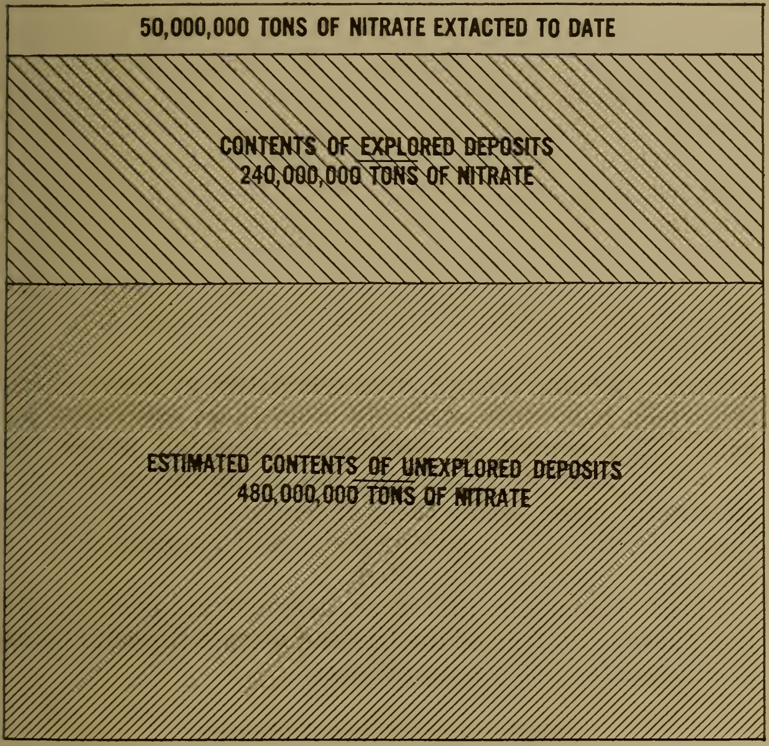
Top of Caliche hopper; Carts tipping Caliche.



Packing Nitrate into bags.

Loading lighters.

As the unexplored part is some 34 times larger than the grounds explored, it is safe to estimate that it contains altogether at least twice the quantity of nitrate of soda, and consequently the nitrate zone in Chile can certainly provide nitrate of soda for another 300 years at the present rate of production.



The quantity of nitrate of soda in the surveyed grounds is distributed as follows:

	Tons remaining.
Tarapaca Province	33,000,000
Tocopilla District	27,000,000
Antofagasta (Central)	31,000,000
Antofagasta (Aguas Blancas District)	48,000,000
Taltal	93,000,000
Chanaral and Copiapo	8,000,000
Total	240,000,000

The Inspector-General of nitrate grounds, in his report to the Chilean Government, has arrived at these figures in the following manner: In these surveyed grounds no raw material containing less than 17 per cent of nitrate of soda has been taken into consideration, nor grounds where the thickness of the nitrate-bearing layer was less than 1 foot, except in the cases of raw material with at least 25 per cent of nitrate of soda, in which cases thickness of 8 inches or over has been included. The superficial area of each portion of ground has been divided by the total number of test holes made, in order to arrive at the area applicable to each test hole, and this consequently determines the total nitrate-bearing area. From the theoretical quantity of pure nitrate of soda resulting from the above operations, a reduction of 40 per cent has been made in order to allow for losses in extraction, manufacture, errors in calculation, etc.

There remain, besides, vast quantities of lower grade ore which have been excluded from these estimates, because they cannot be profitably extracted under the present system of operation; but as improvements are constantly being made, there is every reason to assume that even this low-grade material will be worked when the richer ores are exhausted.

These statements, therefore, demonstrate conclusively that there is no fear of the Chilean nitrate deposits being exhausted for 300 years, at least.

Technique of the Industry.

As the foregoing historical sketch of the manufacture of nitrate shows the process has been about the same from the beginning, the only difference consisting of some mechanical modifications and the use of improved machinery. Chemistry, no doubt, has contributed most toward the betterment of the system, but there is still plenty of room for improvement. The system used at present is based upon the degree of solubility of the principal salts contained in the *caliche* at a temperature above 100° Centigrade. These salts, as we have seen, are nitrate, chloride and sulphate of sodium. The higher the temperature of the water, the greater the solubility

of the nitrate of sodium, and this solubility is in inverse proportion to that of the sulphate and chloride of sodium. However, this system does not solve the commercial side of the problem, since, in order to raise the temperature of the water, a greater quantity of fuel must be consumed, and the better results thus obtained are not sufficient compensation for the expense of this extra fuel. It is also necessary to bear in mind the fact that a heightened temperature would affect, through the dissolving power of the water, the other salts contained in the *caliche,* in proportion to the relative quantity of each. Moreover, a rise in temperature would affect likewise the salts contained in the water used in the dissolving or lixiviation process.

The technique of the industry comprises two different operations: (1) The mining of the *caliche* and its transportation to the machine in which it is to be worked, and (2) The production of the nitrate. The first process is very important, as the amount of profit depends largely upon the expense involved. It is extremely simple when compared with the elaborate machinery necessary in extracting other minerals.

The second process comprises four different operations: (1) the crushing of the *caliche.* (2) the dissolving of the *caliche* in water; (3) the segregating process, and (4) the crystallization of the nitrate.

Crushing machines worked by steam break up the *caliche* and drop it into funnel-shaped carriages, which carry it on tracks to the boiling kettles.

For the dissolving process, a great variety of machines has been employed, but all may be classified under two heads: (1)—those that cause the *caliche* to revolve about in the water to dissolve it; (2)—those that allow the water to percolate through the *caliche.*

Heat is used to give the water the greatest possible dissolving power. This heat has been obtained either by direct contact with fire, or by steam in open or closed pipes.

As may be easily understood, the solution thus obtained contains not only substances soluble in water, but also some which are not soluble. Those not soluble are segregated by allowing them to settle. The precipi-

tation of those in solution is produced by reducing the temperature of the solution to a degree corresponding to its density, affecting first the common salt and then the nitrate. This cooling process is a delicate one, for as soon as the sodium chloride has settled, the precipitation of the nitrate begins, and these two precipitations must take place in different receptacles. For the precipitation and the crystallization of the nitrate, large shallow receptacles are used, called vats (*bateas*), in which the temperature of the solution is reduced to that of the atmosphere. This takes from 24 to 40 hours, or longer. When the water reaches the atmospheric temperature, the nitrate crystallizes on the walls and bottom of the *batea*. Then the water is pumped out and the nitrate gathered together to dry.

From this water (mother lye) iodine is extracted, and it is then used again for the lixiviation of fresh *caliche*. The nitrate which has already crystallized is placed in drying pans for three or four days to allow the remaining water to drain off. It is then taken to the *cancha*, a smooth cemented floor, where it remains from 12 to 15 days until it is entirely dry. It is then packed in bags containing about 200 pounds each, and is finally ready for export.

The *oficinas* are now equipped with the best and most modern machinery, propelled by steam or electricity.

Saltpeter, as exported, is of gray or yellow color, and its composition is as follows:

	Per cent.
Nitrate of sodium	95.0
Sodium chloride	2.0
Sulphate	0.6
Insoluble matter	0.1
Moisture	2.3
Total	100.0

The process of manufacture, apparently so simple, is really a very complicated one, not only because of the great variety of machinery employed, but also on account of the accuracy required throughout the different stages of the process. The nitrate or saltpeter thus ob-

tained is, as already stated, 95 per cent pure, the commercial standard, and contains over 15 per cent nitrogen.

From these facts, one can readily see what an important role water plays in the production of nitrate, and the nitrate zone is in the midst of a desert. A considerable quantity of water is needed in every *oficina,* not only for consumption by the inhabitants, but also for draft animals and for the process of production. The quality of the water is an important factor, as it forms the basis of production, fulfilling as it does two functions in the process: One, physical, modifying the volume and the state of cohesion of the *caliche,* and the other, chemical, giving rise to combinations. Its action upon the *caliche* varies according to the salts it contains, as the dissolving power is modified and the ebullition point reached at different temperatures. In order to obtain satisfactory results, it is necessary, therefore, to make an accurate analysis of the water to be employed. The amount necessary for the production of each Spanish *quintal* is about 46 litres, according to an average taken from several reports. This quantity is augmented or reduced in accordance with the standard of the *caliche* to be treated, a larger quantity being required when the *caliches* are of a lower standard, and a smaller amount when of a higher grade. Besides, the quantity of water necessary also varies according to the type of machine used and the process of manufacture. The water obtained from the wells of the desert differs in quality according to locality.

The second factor playing an important part in the process is fuel. The fuels used in the nitrate industry are coal and gasoline. The greater part of the coal imported, until the outbreak of the European war, came from Great Britain and Australia in sailing vessels which returned laden with nitrate. The gasoline is imported from Peru. Although the use of the latter fuel requires machinery specially adapted, the capital therein invested is repaid, for the cost of transporting gasoline is less and the quantity wasted smaller than in the case of coal.

The consumption of coal may be estimated from the fact that for every unit of coal used, five of nitrate are

produced. As in the case of water, the consumption of coal depends upon the standard of the *caliche.* The richer the *caliche,* the smaller the amount of coal consumed, since the quantity to be heated is smaller, while the nitrate is more concentrated. ✓

The consumption of gasoline is somewhat greater than that of coal, and, therefore, it is used as fuel only in the treatment of rich *caliches.* The average consumption is only one to four.

A most important feature of the heating problem is that of attaining maximum economy in the use of fuel without impairing the ultimate production of nitrate—at present a considerable percentage of caloric power is wasted.

✓ Cost of Production.

✓ This is quite a difficult matter to determine, for the reason that it varies considerably according to the conditions of each particular field,—the standard of its *caliche,* the depth of its nitrate-bearing layers, and so on.

In order, therefore, to arrive at an approximate basis for estimating the cost of nitrate production, we must assume an *oficina* operating in deposits containing the average *caliche* of 30 per cent nitrate, and taking into consideration the various factors entering into the final cost, such as wages, operating expenses, fuel, wear and tear of machinery, etc., we arrive at the figure of 50 cents United States currency per *quintal* at the *cancha.* ✓

In the Appendix will be found a description of the method of transacting nitrate sales.

Uses of Nitrate.

Nitrate of sodium is found in the market in two different grades, viz.: The commercial, with 95 per cent, used for fertilizing purposes, and the refined, with over 96 per cent, applied to manufacturing uses. The following is a partial list of the many uses to which Nitrate is devoted:

As a special fertilizer.
In compounding fertilizers.
In the manufacture of glass.
In the manufacture of explosives.

In the manufacture of fireworks.
In the manufacture of fusing mixtures.
In the manufacture of nitric acid.
In the manufacture of nitrate of potash.
In the manufacture of arsenate of soda.
In the manufacture of steel.
In the manufacture of minium.
For making chlorine in the manufacture of bleaching powders.
In the purification of caustic soda, etc.

Nitrate of Soda as a Fertilizer.

The results obtained in the application of artificial manures are most satisfactory when used in such combinations as to supply the soil with the three principal constituents of plant life,— nitrogen, phosphate, and potash.

Generally speaking, plants can be supplied with nitrogen in four different forms: First, organic nitrogen (dung, green manure, bone meal, blood, fish, etc.); second, nitrogen in the form of ammonia (sulphate of ammonia); third, nitrogen in combination with carbon and lime (nitrolim, calcium cyanamid); fourth, nitrogen in the form of nitrate (nitrate of soda, nitrate of lime.)

Of these four forms, the last named, that of nitrate, is the most beneficial to the crop, for the plant can practically absorb its nitrogen only in this form. It is thus that nitrate of soda takes the first place among nitrogenous fertilizers.

Nitrate of soda, on account of its extreme solubility, is easily absorbed by the plant, thereby entering immediately into its organism and strengthening its roots. This explains the vigorous growth which immediately follows.

On the other hand, nitrate of soda does not exhaust the soil because it really prevents an excessive absorption of phosphoric acid and potash. It also helps to prevent disease and insect pests.

The positive results of experiments undertaken at different times and places by several experts acting independently, coupled with the universal admission of the

increase in weight and value of crops through the application of nitrate, bear witness to the fact that nitrate of soda is the best form in which nitrogen can be supplied to the plant.

Nitrogen in other forms must first be converted into nitrate before it is ready for the plant, but this process is dependent upon temperature and is practically stopped by excessive moisture or drought. This is the reason why nitrogen is not of equal value in the different forms above mentioned.

Several scientists in different countries have individually conducted experiments with the various kinds of nitrogenous fertilizers, and the results obtained have been practically the same,—a fact which furnishes strong evidence of the correctness of their conclusions.

Dr. Edward B. Voorhees, at the New Jersey Experiment Station, carried on experiments for quite a number of years. The results he obtained have been entirely confirmed by similar experiments conducted in Darmstadt and other places in Germany by Dr. Paul Wagner. Both experts reached the conclusion that for every 100 pounds contained in the respective manures, the following weights of nitrogen were recovered in the crop:

	Nitrogen Recovered in Crop	
Manure	Voorhees	Wagner
Nitrate nitrogen	62 lbs.	62 lbs.
Ammonia nitrogen	43 lbs.	44 lbs.
Organic nitrogen (dry blood)	40 lbs.	40 lbs.

The results obtained in Belgium by Dr. G. Smets, of Liege, are similar. Taking nitrate of sodium as a basis, he makes the following comparison of the relative amounts of nitrogen taken up from the different manures: Nitrate of soda, 100; sulphate of ammonia, 75; nitrolim, 69; dry blood, horn-shavings, oil cake and green manure, 65; all others, under 60.

Economic Importance of Nitrate.

Although the population of the world increases rapidly, the consumption of bread increases at a still greater

rate, this being due to the fact that its use among the lower classes is becoming more and more general every day.

This growing demand may be met in two ways: Either by cultivating the virgin lands still available, or by a more intense farming of those already under cultivation. Both methods have been tried, and a glance over the world statistics suffices to show the enormous development that has taken place during the last twenty years in the cultivation of new lands and in the consumption of fertilizers. However, of the two, the second method is the most scientifically economic, since it is cheaper to double the production in an area already prepared for cultivation than to open up new lands. It may be stated as an axiom that the consumption of nitrate increases in different countries in proportion to their scientific development.

Competition with Atmospheric Nitrogen.

There is, and there can be, no competition between Chilean nitrate and atmospheric nitrate. The production of the latter is so small in comparison with the output of Chilean nitrate, that the price of the Chilean article is the one factor that is to determine whether any particular process for the fixation of atmospheric nitrate can be profitable or not. If any danger of competition should arise, it must be due to either of the following causes: When the production of atmospheric nitrate becomes many times larger than at present, or when the Chilean *caliches* begin to be exhausted. The first case is extremely doubtful; the second cannot happen for many, many years to come, as has been shown in the part of this discussion dealing with the extent of nitrate deposits in Chile.

It should be borne in mind that the principal factor in the manufacture of atmospheric nitrate is water power, and, certainly, water power throughout the world is becoming more and more expensive on account of its practical application to the more lucrative industries. Vast sums of money would be required to increase the present production of atmospheric nitrate, while those

seeking an investment would undoubtedly hesitate and be afraid to devote their money to its manufacture because of the uncertainty of being able to compete with Chilean nitrate, a competition which would be bound to be unfavorable to atmospheric nitrate in the probable event of a drop in the price of Chilean nitrate. Moreover, ever since the manufacture of atmospheric nitrate was undertaken, its promoters have been promising and prophesying an enormous output of their article, and yet, in spite of the many years elapsed since then, it has failed to materialize and is very far from attaining the figures promised or even from reaching the low prices expected.

Chilean nitrate can be stored in bags and used at any moment and in any quantity without the slightest detriment to what may be left in the bag, and it is not difficult to handle.

Labor Problem in the Industry.

There have been some disturbances in the *Pampa Salitrera* due to differences between capital and labor. The Chilean Government has appointed special commissions to look into the situation, and has already made important changes.

Life in the nitrate zone is very hard for everybody,— owners, employees and common workmen alike. The first two classes used to find compensation for this hard life in a good table and other material comforts; the workmen, in alcohol.

The trouble between capital and labor was based upon the injustice suffered by workmen in some of the *oficinas*, — instances which although exaggerated by the labor element, were nevertheless supposed to be general in all the *oficinas*. The principal causes of difference were: First, the cost of necessaries, all of which were sold by the *oficinas;* second, the fact that the laborers were not paid in legal currency, but in a special money which the agencies exchanged at the ports; third, the practice of discharging workmen and their families without due explanation. The result of such a state of affairs can be easily imagined.

These commissions reported that it was necessary to provide the lower classes with better material comforts, schools for children, hospitals, places of amusement, etc.; also to suppress the special currency and allow the laborers the free exercise of the right of buying their provisions wherever they chose. The *oficinas* began to provide for these necessities and many of them spent large sums with this end in view.

There was one more thing which called for attention, namely special legislation providing compensation for accidents among workmen, in other words, an employers' liability law, a need which has been met during the past year. Formerly, workmen who met with accidents had no right to compensation unless they could prove that the accidents were due to negligence on the part of the employers. An accident may occur not only through the negligence of the employer, but also through the fault of the workman or an unforeseen chance. In other words, statistics show that less than 25 per cent of accidents are due to the employers' negligence, while another 25 per cent may be traced to the fault of the workmen and 50 per cent to chance. So, under the regulations as they existed prior to the passage of the law above referred to, 75 per cent of the accidents were not attended to. By this law a workman is entitled to half of his salary from the moment the accident occurs until such time as he is able to resume his work. If the accident incapacitates him for life, he is entitled to an income equivalent to 50 per cent of his salary. If he is only partially disabled, he receives a compensation corresponding to two years' salary. In case the workman loses his life, his family is entitled to a yearly income of 20 per cent of his salary, the amount being fixed by the court and the salary paid monthly. If the salary was a variable one, the judge fixes an average. This law provides not only for the nitrate industry, but also for all the other industries in Chile.

Effect of the European War on the Nitrate Industry.

The first result of the European war has been an upset in the statistics of the industry, not only on account of

the difficulty in obtaining accurate information from the countries involved in the war, but also because the quantities of nitrate used for industrial purposes have, without doubt, been far above the normal figures for the previous years.

Many of the more important consuming markets have been cut off, and the means of transportation, considerably curtailed. These conditions influenced almost immediately the production of nitrate. Some *oficinas* closed down at once, but the greater number continued in operation during the month of August, 1914. In September of the same year the output showed a remarkable decrease, and of the 170 *oficinas* at work before the war, only 34 were active at the end of the year. The production, which had averaged about 5,000,000 *quintals* a month fell to less than 2,000,000. The stocks on the Coast, in August and September 1914, exceeded 1,100,000 tons, as a result of the heavy production in June and July, coupled with small shipments in August and September. Soon after the declaration of war, nitrate exports to Germany, Belgium, and very important districts of France, ceased. Then, again, the scarcity of bottoms, due to loss and internment of ships, has produced an enormous increase in freight rates.

The ordinary freight rate from Chile to Europe before the war ranged from $6 to $7.50. As the war progressed the rate rose, and by degrees went up to $20, at which figure it remained for some time, only to rise again lately to $25, and even higher.

The exports from July to December, 1914, reached only 14,003,252 *quintals;* making a total for the year 1914 of 40,147,500 instead of 60,000,000 exported in 1913. During the first half of the present year, the exportation was 18,067,462 *quintals,* while during the second half, with estimated figures, for the months of November and December, it will amount to 22,600,000 *quintals;* making a total for the year of 40,067,462 *quintals.*

The war has diminished the exportation in 1914 by 20,000,000 *quintals,* and for the present year by a similar figure; and over and above this figure there is the failure of the natural increase which was reasonably

expected, considering that each year the export figure has increased by several million *quintals*.

Of course, the price for the consumer has likewise been affected, not only on account of the rise in freight rates, but also by reason of the speculation in the different markets due to fear of lack of transportation facilities.

However, the ultimate effect upon the finances of the country has not been so disastrous as has been said. It is true that the Government has received only two-thirds of the normal export duties, but this curtailment in the income of the Treasury has been compensated by an additional tax and by economies introduced in the budget.

In regard to the country itself, the results were a serious crisis during the second half of 1914, followed by a much healthier condition during the present year. The crisis caused the restriction of credit in the banks, a decrease in the imports, and consequently, a diminution in payments in foreign markets, which has resulted in the slow but steady rise in the ratio of exchange and economy among the people.

In May, 1915, many of the *oficinas* that had been closed resumed work as a consequence of the rise in nitrate prices and the *pampa* is now in full activity.

Nitrate Combination.

The world consumption of nitrate did not keep pace with the rapid development of the industry after the Pacific War, which gave Chile possession of the Nitrate Zone (1881), and, naturally the price of the article fell. This crisis of the industry was felt more intensely on account of the crisis that the sugar beet industry was undergoing at the same time in Europe. Such a situation forced the different companies to unite and form a *Combination,* which had for its object the division of the world consumption among its various members, each being allotted a quota of production in proportion to its own producing capacity. This measure almost immediately caused a rise in the price. At any rate the *oficinas salitreras* were able to produce almost twice the amount

allotted to each of them. Very expensive machinery had already been acquired for production on a larger scale, and the necessity of increasing the world consumption was evident. This was the reason for the organization of a committee, which took up the work of propaganda, not only in those countries where nitrate was known, but also in such where the possibility for new markets was evident. After a short time, the wonderful work of this committee became manifest. Between 1886 and 1890 it managed to raise the world consumption from 9,000,000 to 23,000,000 *quintals*. To-day it has organized sub-committees or delegations in almost every country in the world. The propaganda is essentially of a scientific nature, and the delegations attend to all technical inquiries from consumers. The committee has its headquarters in London.

The exportation of nitrate began in very small quantities in 1830. In the period between 1830 and 1835, 360,000 Spanish *quintals* were exported. At the present time, in a like period, the exportation reaches 300,000,000 Spanish *quintals*.

Nitrate Railways.

As a logical result, the development of the nitrate industry brought about the construction of railway lines needed for transporting the article to the shipping ports.

The first railway built in the nitrate zone was that from Iquique to Moria, the construction of which was begun in 1868 by the firm of Montero & Brothers, under a contract with the Peruvian Government. Its operation was begun in 1875.

The nitrate railways have been constructed by private companies independent of each other, with the result that there is no harmony in the whole, their gauges, rolling stock and systems of operation being quite different.

The ports to which the various lines lead are, from North to South: Pisagua, Junin, Caleta Buena, Iquique, Tocopilla, Mejillones, Antofagasta, Caleta, Coloso and Taltal. The railway systems affording an outlet for nitrate to the ports mentioned belong, as already stated, to different companies, for which reason we will consider them by groups according to companies.

The Nitrate Railways Company carries the nitrate to the ports of Pisagua and Iquique; the Junin Railway, to the port of the same name; the Agua Santa line, to Caleta Buena; the Anglo-Chilean Nitrate and Railway Company, to Tocopilla; the Antofagasta and Bolivia Railway Company, to Antofagasta; and the Coloso and Taltal lines to the ports of these names.

The characteristic of the nitrate railways is that they are formed by trunk lines from which radiate a series of branches to the different *oficinas,* and that they have been built under special contracts guaranteeing a minimum tonnage of freight.

The capital invested in nitrate railways proper exceeds 12,000,000 pounds sterling.

Nitrate of Soda in the United States.

The enormous development in agriculture that has taken place in this country during the last years,—a development no doubt due to the more general instruction in agriculture, and to the work of experiment stations established throughout the different states,—is the cause of the rapid increase in the use of fertilizers, among them, nitrate of soda.

In 1850 there were 1,449,073 farms, with a total acreage of 293,560,614.

In 1880 there were 4,008,907 farms, with a total acreage of 536,081,835.

In 1910 there were 6,361,502 farms, with a total acreage of 878,798,325.

If we look into the statistics of production, we will find that the increase is proportionately larger than that of the land under cultivation. This difference is due to improved methods of cultivation, the use of fertilizers, the better organization of the industry, the wider dissemination of agricultural training, and the experiment stations established in different states.

In the last ten years the consumption of nitrate has doubled. The importation in 1904 was 293,574 tons, and in the year ending the 30th of June 1914, it was 564,000 tons. The consumption for the present year is over 600,000 tons. At no distant date this figure will

almost reach that which represents the present production of nitrate in Chile. This result appears almost certain if we study the increasing percentage of cultivation, together with the constant increase in the lands under cultivation.

Without taking into consideration the commercial interchange of other products between the United States and Chile, the urgent necessity of providing steamship facilities between the two countries is manifest.

United States exports to Chile in 1904 amounted to $4,798,526, while in 1914 they were $17,408,724. Chilean imports into the United States, which in 1904 amounted to $10,775,810 have now reached the figure of $25,722,128.

The above figures show at present a balance of trade in favor of Chile amounting to $8,289,736, but it must be pointed out that very often a wrong conclusion is drawn from them. The commercial exchange between the United States and Chile must be studied without regard to the trade in nitrate of soda, as this country cannot buy this substance anywhere else, and if we deduct the value of this article, the proportion of exchange and the result are opposite. Chile buys five dollars' worth of products in the United States for every dollar's worth which the United States buys in Chile.

Part Played by the Nitrate Industry in the Economic Life of the Country.

When it is considered that the nitrate industry by itself supports numerous railway companies, and constitutes almost 50 per cent of the total freight of the coastwise trade,— since the zone itself is sterile and almost all the articles and provisions required for its consumption have to be brought from other parts of the country,— the important part it plays in the economic life of the country may be easily understood.

Five per cent of the total population is found in the nitrate zone. Aside from agriculture, this industry pays in salaries one-third of the total amount devoted to salaries in all the other domestic industries. One-fourth of the capital invested in the various industries in Chile is devoted to the nitrate trade.

Conclusions.

Why is it that Chilean nitrate, its qualities as a fertilizer being well known, is not used now throughout the world, and in much larger quantities?

This question does not imply that its consumption has not increased considerably. One can easily see in the tables of exports that its use is becoming more general every day; but has it reached the figure that it should, considering the fertilizing properties of the substance? No; and as this phase of the problem is very interesting, we must study it.

Propaganda of a scientific nature, which is more serious and profitable, has not been disregarded, but it could well be more intense. Industrial and commercial propaganda, it may be said, exists only on a very small scale.* So far, the nitrate industry has not attempted to popularize the use of this product in other ways than as a fertilizer. What has been done in this direction is due to the efforts of manufacturing industries throughout the world, on their own initiative.

As we have said, commercial propaganda, properly speaking, does not exist in the industry. This system has reached a high degree of development in the United States in all industries, with results well known to every one, and it might well serve as an example to the nitrate trade of Chile. But at the same time, it ought to be accompanied by facilities for the acquisition of the substance. This part of the problem does not interest Chile alone; it should interest still more the agricultural countries, since the productive power of the land is doubled by the use of nitrate, at a very small expense comparatively. Besides, competition of other fertilizing

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* Publisher's Note.— In this connection it is interesting to note that nothing was done, by way of Scientific Propaganda in North America, until 1898, when the Office of Propaganda was established here in New York.

The three year period tonnages of Nitrate Consumption in the United States are especially interesting as fairly indicating the result of this work.

Three-Year Period Tonnages of Nitrate Consumption in the United States.

1889–91	281,000	Tons	
1892–94	304,000	"	
1895–97	340,700	"	
1898–00	480,000	"	New York
1901–03	677,000	"	Propaganda
1904–06	940,900	"	Office
1907–09	1,059,400	"	Opened
1910–12	1,509,700	"	March, 1898

products ought to be considered, and this is what interests the nitrate industry more than it does other countries. The only solution of the problem lies in the reduction of the price, but how shall this be accomplished? Very different factors must here be considered, and they must be classified before we can gain an exact knowledge of the question.

One factor is the cost price of the nitrate, and the other is its price when it reaches the consumer. In dealing with the cost price, we must take into consideration different things, the price of the raw material, that is, the price of the *caliche* on the ground, the cost of production, transportation to the port, shipping facilities, discount on the drafts corresponding to the total value of the sale price, and the profit which must be left to the capital invested in the industry. These factors constitute the first group. A second group may be formed by maritime and land freights, insurance and commission to middlemen. Finally, speculation, profit of the dealer in fertilizers, and interest on the value of the quantity bought by the farmer, who generally pays for his fertilizer when he harvests his crops; these may form the third group.

We shall now analyze each group, to see in which one the price might be reduced.

The cost of the Nitrate land is a value more or less fixed, with a tendency to increase. As in every industrial business, the price tends to increase in greater proportion than the interest on the capital, and it could not be much modified by the action of the industry. The cost of production might be lowered by perfecting the methods in use, for the purpose of extracting the greatest possible quantity of nitrate from the *caliches,* and economizing fuel. As for transportation to the port and shipping facilities, these have advanced a great deal; but conditions might still be bettered, and the Chilean Government is now giving attention to this matter.

Discarding these factors, which give little promise of economy, we come to those related to the commercial side of the nitrate industry.

Freight Charges.— The disturbed conditions resulting from the war in Europe have brought about a complete

change in all freight charges, including those on nitrate. The destruction of a considerable number of steamers, and further losses in this direction, which may be expected before the war ends, will reduce appreciably the means of transportation. So the freight rate, after the war, will be, if not the same as at present, at any event higher than before the war. The nitrate trade, as well as other industries, not only in Chile, but also in other countries, will require an increase in steamship facilities in order to replace the service formerly furnished to a great extent by companies in the belligerent countries. This policy is in process of development in the United States, and in Chile it may easily be encouraged by laws promoting the development of our national steamship lines.

What is said in regard to steamship facilities may also be said in regard to insurance companies in Chile, for which there is a great chance for growth.

The commissions earned by middlemen who often speculate, form a group in which reductions of importance may be brought about, by changing the system now used for another, such as the project of the centralization of sales, a system that would result in real economy of expense, and also prevent fluctuations in the price,—a very important feature in the increase in consumption. Any marked fluctuation in the price has a two-fold influence. The farmer is not inclined to pay more for his fertilizer one year than he has paid the previous year. He is very quick to complain of a rise in price, but takes no notice of a reduction when it comes. On the other hand, the dealer in fertilizers, when the price fluctuates, never knows what profit he is to derive from the sale of a certain quantity of nitrate, and sometimes even the profit is changed to loss. For this reason he prefers to encourage the sale of other fertilizers which bring him a sure margin of gain, and he then becomes a propagandist against the use of nitrate. I know of some merchants who have nitrate in their stores solely to avoid the accusation that they have not a complete stock of fertilizers; and in some instances they sell nitrate only on condition that the farmer buys a much larger proportion of other fertilizers.

There are numerous markets which are closed to-day to Chilean nitrate,— markets in which there is no consumption because there is no nitrate on sale, and others where there is none on sale because there is no consumption. The time has now come to break down this syllogistic circle, and this may easily be accomplished by commercial propaganda.

The nitrate industry must be reorganized, and taking into consideration the different parties interested, this cannot be accomplished without the intervention of the Government.

Some of the nitrate companies produce the substance at a low price, the desideratum for them being to produce and sell great quantities at such a price as will leave them some profit. Others produce at a higher cost, preferring to produce less and sell at a high price. On the other hand, the object of the middlemen is to buy at a low price and sell at a higher one.

The interest of the Chilean Government lies in the exportation of the greatest possible quantity, the utilization to the utmost of the substance as found in the soil, and the increase of consumption by regulating the price in the different markets as nearly as possible. So the interest of the Government and that of the producers are not separate; and the Government, being interested, as it is, in the production of all the different companies, has not only the right, but almost the duty to interfere in the organization of this industry which constitutes the most important basis of its economic life.

This is not something new and unusual. The German Government interfered in the potash industry without owning the raw material. And in Sicily, in the sulphur industry, the same thing has been done.

APPENDIX

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APPENDIX.

Nitrate Exports.

The exportation of nitrate began in 1830, in very small quantities. Now it has reached the high figures shown in the following table. The amounts are stated in Spanish *quintals,* one *quintal* being equal to 101.44 pounds.

Years.	Spanish Quintals.	Years.	Spanish Quintals.
1830–1834........	361,386	1889.............	20,682,000
1835–1839........	761.349	1890.............	23,373,000
1840–1844........	1,592,306	1891.............	18,739,000
1845–1849........	2,060,592	1892.............	17,478,000
1850–1854........	3,260,492	1893.............	20,655,161
1855–1859........	5.638,763	1894.............	23,947.014
1860–1864........	6,979,208	1895.............	27,285,205
1865–1869........	10,594,026	1896.............	25,175,832
1869.............	2,507,000	1897.............	24,971,648
1870.............	3,943,000	1898.............	27,903,553
1871.............	3,606,000	1899.............	30,213,532
1872.............	4,421,000	1900............	31,741,293
1873.............	6,264,000	1901.............	27,691,298
1874.............	5,583,000	1902.............	30,089,440
1875.............	7,191,000	1903.............	31,694,954
1876.............	7,317,000	1904.............	32,696,180
1877.............	4,991,000	1905.............	36,717,472
1878.............	7,023,000	1906.............	37,564,460
1879.............	3,161,000	1907.............	35,987,237
1880.............	4,869,000	1908.............	44,587,177
1881.............	7,739,000	1909.............	46,390,656
1882.............	10,701,000	1910.............	50,781,241
1883.............	12,820,000	1911.............	53,250,327
1884.............	12,152,000	1912.............	54,197,439
1885.............	9,478,000	1913.............	59,529,110
1886.............	9,805,000	1914.............	40,147,463
1887.............	15,495,000	1915 (Jan. to June)	18,067,462
1888.............	16,682,000	1915 (July to Nov.)	21,500,325

Method of Transacting Nitrate Sales.

The following is a brief account of the different transactions which Nitrate undergoes from the time it is purchased at port of shipment to the time it is delivered to the consumer. The operations vary to some extent, such as for instance in the case of Valparaiso and London payment, weighing on arrival, etc.; but in general the various operations are, briefly as follows:

Under the contract Nitrate is purchased for delivery at a named port on a specified date, and the buyer is allowed 40 days from that date in which to provide a vessel to load the Nitrate at the particular port named in the contract. If the vessel is not ready to load within the time allowed, the Nitrate remains in the warehouse at the risk of the buyers, who must pay rent thereon. Payment for the Nitrate is due at the expiration of 30 days from the delivery date, whether or not the Nitrate is loaded.

On arrival of the vessel to load the Nitrate, notice is given by the buyers to the sellers in accordance with contract, and the Nitrate is thereupon delivered by sellers under superintendence of buyers, and lightered to the vessel. Samples are taken by both buyers and sellers, and sent to the official assayers in Valparaiso for analysis, the mean of two being the basis for calculating refraction.

In due course, advice of delivery on the contract is telegraphed to Valparaiso, and if it is "Coast payment," payment is made in Valparaiso in first class drafts on London at 90 days' sight. If the contract is for "London payment," sellers retain Bills of Lading and forward them to London, where in due course they are taken up by buyers against payment in cash under discount, or free of discount if the vessel has not arrived before due date reckoned at 90 days sight from arrival of Bills of Lading in London. In the case of "London payment," buyers have to insure the Nitrate, and deposit the insurance cover with the sellers until payment is made.

Upon the vessel completing her loading, buyers give the Captain her sailing orders, which may be for a direct port or for a port for orders.

Upon arrival of the vessel at destination she must be discharged according to the custom of that particular port unless any special conditions are stated in the charter. Usually the Nitrate is weighed on arrival, and either put in storage in the port or into lighters or railway trucks for delivery into the interior, where it is either stored or sent straight through to consumers.

Freight is payable at port of destination — one-third on arrival of the vessel and the balance when called for according to the quantity discharged.

Such bags as may have become damaged on the way are, provided that they are not too much damaged, repaired, and any loose Nitrate rebagged into new bags. These operations are done on board, the receivers providing the bags and twine, and the ship the labor. The ship pays the stevedoring at the port of discharge.

It is customary to insure against Marine risk and War risk now and in the case of an exporter selling on cost and freight or cost, freight and insurance terms, the Nitrate has to be covered for 10 per cent over the sale price.

There is another custom with regard to sales made on cost and freight or cost insurance and freight terms, which is that the Nitrate is invoiced on the shipping weight in *quintals* converted at the rate of 101.44 pounds English net equal to 100 pounds Spanish net. Freight is deducted from the invoice to the c. & f. or c. i. f. buyer at the arbitrary conversion of 10,000 *quintals* Spanish net equal to 435 tons English gross, while the buyers pay the freight to the ship owners on the actual outturn weight. On this conversion the freight payable by the buyer is roughly 3.94 per cent greater than the sum deducted in the Invoice. In c. & f. sales Marine Insurance and War Risk is covered by sellers for buyers account — buyers refund the gross cost on lifting documents while sellers retain any allowances granted by underwriters in the way of discount or what not. As to brokers, it is customary to employ them both on the coast and in Europe.

Nitrate of Soda as a Fertilizer.

Nitrate of Soda and sulphate of ammonia being the two most important of all fertilizers, have been very closely studied. Stutzer published a table giving the average increase in various crops due to the use of nitrate of soda instead of sulphate of ammonia. It is as follows:

Average increase in pounds.	Crop.	Number of experiments.
196	Rye	4
55	Wheat	88
125	Barley	81
360	Potatoes	36
2,024	Beets	144
321	Hay	38
3,825	Mangolds	36

The following tables and illustrations show the results obtained in some of the experiment stations.

Experiments with Fertilizers on Sweet Potatoes.

Kind of Fertilizer and quantity per acre.	Cost of Fertilizer.	Bushels per acre. Large.	Small.	Total.
1. No manure	......	157	51	208
2. 320 lbs. bone-black, 160 lbs. Muriate of Potash	$7.70	205	36	241
3. 200 lbs. Nitrate of Soda, 320 lbs. bone-black, 160 lbs. Muriate of Potash	12.34	270	58	328
4. 20 tons stable manure........	$30.00	263	61	324

South Carolina Experiment Station.

(Clemson College, S. C.)

Cotton.

Results of experiments in 1906. Fertilizer per acre. Lbs.		Yield per acre. Lbs.	Results of experiments in 1908. Fertilizer per acre. Lbs.		Yield per acre. Lbs.
None	....	610	None	....	349
352	Acid Phosphate	627	704	Acid Phosphate	689
44	Muriate of Potash...	651	88	Muriate of Potash...	410
352	Acid Phosphate,		704	Acid Phosphate,	
44	Muriate of Potash..	677	88	Muriate of Potash...	636
352	Acid Phosphate,		704	Acid Phosphate,	
44	Muriate of Potash,		88	Muriate of Potash,	
88	Cottonseed Meal	726	176	Cottonseed Meal ...	901
352	Acid Phosphate,		704	Acid Phosphate,	
132	Nitrate of Soda.....	891	264	Nitrate of Soda.....	954
352	Acid Phosphate,		704	Acid Phosphate,	
44	Muriate of Potash,		88	Muriate of Potash,	
132	Nitrate of Soda.....	1,040	264	Nitrate of Soda.....	993
352	Acid Phosphate,		704	Acid Phosphate,	
88	Cottonseed Meal,		176	Cottonseed Meal,	
132	Nitrate of Soda.....	1,133	264	Nitrate of Soda.....	1,033
352	Acid Phosphate,		704	Acid Phosphate,	
44	Muriate of Potash,		88	Muriate of Potash,	
88	Cottonseed Meal,		176	Cottonseed Meal,	
132	Nitrate of Soda.....	1,215	264	Nitrate of Soda.....	1,073

Hops.

A Record of Four Years' Experiments with Hops.

The experiments were conducted at Golden Green, Hadlow, near Tunbridge, England, and under the supervision of Dr. Bernard Dyer. Seven plots were arranged, all except No. 7 receiving equal and ample quantities of phosphoric acid and potash, but varying amounts of Nitrate of Soda, and (plot 7) thirty loads of stable manure. The fertilizing of the plots, and the average crop, kiln dried hops per acre, with the percentage of gain over the plot not treated with Nitrate, are shown in the following table.

Plot and Fertilizer.	Kiln dried hops.	Gain per cent.
1. No Nitrate	9.75 cwt.	......
2. 2 cwt. Nitrate	12.00 "	23
3. 4 " "	13.67 "	39
4. 6 " "	13.75 "	41
5. 8 " "	14.58 "	49
6. 10 " "	14.58 "	49
7. 30 loads manure	10.25 "	5

Wheat.

According to the "Book of Rothamsted Experiments," 1905, the average crops produced during a period of 51 years on plots of ground fertilized with different manures was as follows:

	Bushels per acre.
No manure	13.1
Minerals with no Nitrogen	14.9
Minerals with 43 lbs. Nitrogen	24
Minerals with 86 lbs. Nitrogen	32.9
Minerals with 129 lbs. Nitrogen	37

and the increases in straw are even more marked.

It is also said that experiments covering a period of ten years (1892–1902) showed that nitrate of soda produces more nitrogen than ammonia salts, yielding 16 per cent more grain and 26 per cent more straw.

Barley.

The following table is given as representing the result of 50 years' experiments on barley:

Manure.	Dressed grain. Average 50 years. Bushels.	Straw. Average 50 years. Cwts.
No minerals and no Nitrogen	15.3	8.8
Superphosphate only and no Nitrogen	20.0	10.2
Alkali salts only and no Nitrogen	16.2	9.0
Complete minerals, no Nitrate	20.5	10.7
Nitrate of Soda alone	30.5	18.2
Superphosphate and Nitrate	43.9	26.2
Alkali salts and Nitrate	31.7	19.9
Complete minerals and Nitrate	43.6	27.4

Cotton.

The following table shows the results of experiments made on the farm of Mr. J. C. Moore near Auburn, Alabama. The ground was laid off into four plots, each containing ten rows, and covering one-sixth of an acre.

Plot.	Fertilizers used.	Lbs. per acre.	Yield per acre. in 1905 lbs.	Yield per acre. in 1906 lbs.
1.	Acid Phosphate	300	750	930
2.	Acid Phosphate	300	....	....
	Nitrate of Soda	42	1,116	900
3.	Acid Phosphate	300	....	....
	Nitrate of Soda	84	1,272	1,284
4.	Acid Phosphate	300	....	....
	Nitrate of Soda	126	1,440	1,776

It will be readily seen by this table that through the addition of nitrate of soda, the yield of both dressed grain and straw was more than doubled in every case.

Maryland Agricultural Experiment Station.

Bulletin No. 91, Page 44, Table 7.

Nitrate of Soda vs. No Nitrate of Soda Applied on Wheat; Wheat Unfertilized in Fall.

Plot No.		Yield of grain per acre, bushels.
1.	Neither fertilizer nor Nitrate of Soda	10.4
2.	Nitrate of Soda with no other fertilizer	18.1

Top-Dressing Experiments.

The official Agricultural Experiment Stations have made many experiments to determine the value of top-dressings of Nitrate of Soda, particularly the New Jersey Station. The work of this station demonstrated the profit value of Nitrate top-dressing on various fruits and vegetables. The Rhode Island Experiment Station made a top-dressing test on grass land and the results also indicated a profitable use of this chemical fertilizer.

The experiment was made on three plots, all of which were treated with ample quantities of Phosphoric Acid and Potash. One plot received no Nitrate, one plot a top-dressing of 150 pounds per acre, and the remaining plot a top-dressing of 450 pounds of Nitrate per acre. The seed used was one-quarter red clover, one-quarter redtop, and one-half timothy. The yield in barn-cured hay was as follows:

	Tons
No Nitrate	1.60
150 lbs. Nitrate	2.24
450 lbs. Nitrate	3.28

The season was not good hay weather on account of an early and severe drouth, yet the top-dressing of 150 pounds of Nitrate of Soda, per acre increased the crop of hay 40 per cent. and the top-dressing of 450 pounds gave an increase of 105 per cent. In summarizing the results the Station reports that in spite of the weather being so unfavorable that there was practically no second crop, a top-dressing of 150 pounds of Nitrate of Soda per acre increased the crop in value $6.94, at a cost for Nitrate of $3.30; a top-dressing of 450 pounds per acre increased the value of the crop $16.98 at a cost of $9.90.

Experiments on Tobacco at the Kentucky Experiment Station.

Fertilizer per acre.	Yield of tobacco, pounds. Bright.	Red.	Lugs.	Tips.	Trash.	Total.	Value of tobacco per acre
1. No manure	....	200	360	60	540	1,160	$67 20
2. 160 lbs. Nitrate of Soda	230	450	310	90	530	1,610	138 40
3. 160 lbs. Sulphate of Potash; 160 lbs. Nitrate of Soda	190	755	605	120	140	1,810	190 45
4. 320 lbs. Superphosphate; 160 lbs. Sulphate of Potash; 160 lbs. Nitrate of Soda	310	810	420	10	360	2,000	201 20

Wheat Experiments in England.

From 100 to 150 pounds of Nitrate of Soda per acre should be broadcasted on wheat, as soon as the new growth shows in the spring. The results of such treatment are shown by experiments made by three English gentlemen, which are tabulated as follows, mineral plant food being present in abundance:

I. No Nitrate, 23 bu.	300 lbs. Nitrate, 33.5 bu.	Gain 46 per cent.
II. No Nitrate, 15 "	300 lbs. Nitrate, 28.0 "	Gain 87 " "
III. No Nitrate, 34 "	300 lbs. Nitrate, 49.0 "	Gain 44 " "
Average gain		59 per cent.

REPORTS OF OFFICIAL EXPERIMENTS.

South Carolina Agricultural Experiment Station.

From Bulletin No. 56, Page 5.

Wheat.

I. Comparison of Varieties.
II. Quantity of seed per acre.
III. Experiment with Nitrogen.
IV. Home Manures.
V. Commercial Fertilizers.
VI. Tillage.

If wheat is sown upon land deficient in organic matter, it is wise to use a complete fertilizer, containing Nitrogen, phosphoric acid and potash.

If wheat shows an unhealthy appearance in early spring, especially upon sandy lands, an application of seventy-five pounds of Nitrate of Soda will prove beneficial provided there is enough phosphoric acid in the soil to co-operate with it to make the grain.

Experiment with Nitrogen.

To compare effects of Nitrogen from cotton-seed meal and Nitrate of Soda, the latter applied with the seed and as a top-dressing, the intention was to use on each plot a constant quantity of phosphoric acid and potash as the equivalent of these ingredients in 200 pounds of cotton-seed meal.

	Bus.
The first plot received Cottonseed Meal alone — yield.......	17.5
The second, Phosphoric Acid, Potash and Nitrate of Soda all applied with the seed — yield......................	20.8
The third received only Phosphoric Acid and Potash — yield.	17.6
The fourth received in addition to Phosphoric Acid and Potash applied with the seed, Nitrate of Soda as a top-dressing — yield	19.4

Nitrate Railways.

1. *The Nitrate Railways Company* (including the Pisagua and Lagunas Branch)— Value of lines, £4,000,000; length of lines, 585 kilometers; gauge, 1.435 meters; annual traffic, about 500,000 passengers and 1,200,000 tons of freight.

These lines connect the Tarapaca deposits with the ports of Iquique and Pisagua. The trunk line is 250 kilometers, and the branches, 335.

Starting from Pisagua, the trunk line goes inland as far as Jazpampa, from whence it takes a southerly direction as far as Lagunas. Another section starts from the port of Iquique and connects with the trunk line at La Noria.

2. *The Junin Railway.*— This line affords an outlet through Caleta de Junin for the nitrate produced in the Department of Pisagua. It is owned by the Compania de Salitres y Ferro-carril de Junin. The line starts from the height of Junin at 664 meters above sea level, and connects with La Caleta by means of inclined planes. Gauge, 0.762 meters; length of line with branches, 103 kilometers; cost of line, £265,000.

3. *The Caleta Buena and Agua Santa Railway.*— This line connects the nitrate fields in the Agua Santa, Negreiros and Huara with Caleta Buena. The line in the height is linked with La Caleta by means of inclined planes which overcome the altitude of 745 meters above the pier.

This line belongs to the Compania de Salitre y Ferrocarril de Agua Santa. Gauge, 0.762 meters; length, 103 kilometers. At kilometer 29 the line divides, one branch going to Agua Santa and the other to Huara. It is valued at £460,000 and carries an annual traffic of about 6,000 passengers and some 400,000 tons of freight.

4. *The Anglo-Chilean Nitrate Railway.*— This line operates in the nitrate fields of the Toco district. Its value is estimated at £650,000, with an annual traffic of about 65,000 passengers and 400,000 tons of freight. The extent of the line is 123 kilometers, and its gauge, 1.067 meters.

5. *The Antofagasta and Bolivia Railway.*— This line, although an international one, since it connects the Chil-

ean port of Antofagasta with the cities of Oruro and La Paz in Bolivia, has not lost its original characteristic as a nitrate railway, because its most important section has for its object the transportation of nitrate. It is owned by the Antofagasta and Bolivia Railway Company, the value of whose railroads and water works is about £9,000,000. The total length of the line is 1,156 kilometers, of which 435 kilometers are comprised in the Chilean section between Antofagasta and Ollague, not including the branches to the nitrate districts, which branches, with their sub-branches, have a length of 425 kilometers. The gauge is 0.762 meters.

It carries yearly some 280,000 passengers, and about 1,500,000 tons of freight. Its receipts amount to £1,000,000 per year, approximately. Its principal branches are:

	Kilometers.
Prat-Mejillones	77
Antofagasta to above branch	35
Boquete branch	111
Collaguasi branch	96
Minor branches	106

6. *The Caleta Coloso-Aguas Blancas Railway.*— The production from the nitrate fields in the Aguas Blancas district finds an outlet through this line, whose length is 186 kilometers, besides 50 kilometers in branches and sub-branches. Its gauge is 0.762 meters.

At kilometer 92 it divides into two series of branches; those of the north reaching as far as the Oficina de Castilla, and those of the south, as far as the Oficina de Valparaiso; at about the same point another branch starts, connecting with Pampa Rica. It carries yearly about 250,000 tons of freight.

The cost of this railway and the port works amounts to £950,000. Its revenues may be estimated at £112,500 a year.

7. *The Taltal Railway.*— This railroad gives an outlet to the nitrate from the interior of the Atacama desert. It belongs to the Taltal Railway Company. Its length is 300 kilometers; its gauge, 1.067 meters, and its cost is estimated at £1,250,000. Its annual business amounts to some 85,000 passengers and 500,000 tons of freight.

Imports of Nitrate of Soda to the United States.

Year.	Tons.	Year.	Tons.
1889	79,000	1902	107,000
1890	104,000	1903	264,000
1891	98,000	1904	274,000
1892	97,000	1905	305,000
1893	107,000	1906	361,900
1894	100,000	1907	351,600
1895	127,000	1908	308,800
1896	106,500	1909	399,000
1897	107,200	1910	503,600
1898	145,000	1911	537,000
1899	155,000	1912	469,100
1900	180,000	1913	560,000
1901	192,000	1914	527,895

Average Price in the United States.

From July, 1913, to present date.

	1913.	1914.	1915.
January	......	$2.24	$1.88
February	......	2.24	2.08
March	......	2.26	2.19
April	......	2.24	2.27
May	......	2.21	2.30
June	......	2.15	2.29
July	$2.18	2.12	2.28
August	2.45	2.18	2.32
September	2.40	2.04	2.41
October	2.40	1.93	2.79
November	2.31	1.93	2.95
December	2.20	1.93	3.00

Nitrate Companies.

In its earliest days, it was British capital that contributed most to the development of the industry. At present Chilean and German money are also freely invested.

The following table shows the different companies and the proportionate production:

Name of The Oficina.	Stock.	Production in one year.	Total.
1. Abra	21,176	125,760	146,936
2. Aconcagua (Antofagasta)	136,874	677,485	814,359
3. Adriatico (ex-Neuva Palmira)	31,084	28,338	59,422
4. Aguada	41,593	186,014	227,607
5. Agustin Edwards (Antofagasta)	226,158	1,300,461	1,526,619
6. Agua Santa	104,418	435,747	540,165
7. Alemania (Taltal)	133,585	728,452	862,037
8. Alianza	426,765	1,422,380	1,849,145
9. Alianza (Taltal)	....	....	....
10. Amelia	85,727	257,750	343,477
11. Angamos (ex-Carmen) (Antofagasta)	25,500	610,069	635,569
12. Angela	90,353	330,563	420,916
13. Anibal Pinto (Antofagasta)	139,837	1,146,869	1,286,706
14. Anita (Antofagasta)	183,520	556,341	739,861
15. Aragon	....	....	....
16. Argentina	151,888	144,865	296,753
17. Arturo Prat (Antofagasta)	....	706,095	706,095
18. Atacama (Taltal)	....	....	....
19. Aurelia (Antofagasta)	....	253,018	253,018
20. Aurora	....	125,448	125,448
21. Aurrera	307	202,614	202,921
22. Ausonia (Antofagasta)	150,675	722,115	872,790
23. Avanzada (Aguas Blancas)	72,157	439,958	512,115
24. Ballena (Taltal)	66,909	461,341	528,250
25. Barcelona	26,403	114,921	141,324
26. Bellavista	100,000	918,385	1,018,385
27. Bonasort (Aguas Blancas)	94,232	478,061	572,293
28. Britannia (Taltal)	....	....	....
29. Buen Retiro	....	....	....
30. Buena Esperanza (Toco)	70,866	198,698	269,564
31. Buenaventura	....	....	....
32. Cala-Cala	190,099	437,978	628,077
33. California	67,296	206,543	273,839
Forward	2,637,422	13,216,269	15,853,691

Name of The Oficina.	Stock.	Production in one year.	Total.
Forward	2,637,422	13,216,269	15,853,691
34. Camina	4,049	325,205	329,254
35. Candelaria (Antofagasta)	109,106	377,755	486,861
36. Carmela (Antofagasta)	125,089	413,879	538,968
37. Carmen Bajo	163,609	697,469	861,078
38. Castilla (Aguas Blancas)......	....	....	....
39. Cecilia (Antofagasta)	234,089	720,885	954,974
40. Celia (Antofagasta)	....	198,396	198,396
41. Compania	23,816	154,337	178,153
42. Condor	....	....	....
43. Constancia	71,253	367,447	438,700
44. Cota (Aguas Blancas)........	131,641	496,648	628,289
45. Chile (Taltal)	148,580	1,329,766	1,478,346
46. Cholita y Yungay Bajo........	91,998	173,135	265,133
47. Coya (Toco)	39,039	1,653,121	1,692,160
48. Curico (Antofagasta)	207,738	740,314	948,052
49. Delaware (ex-Carolina Taltal).	33,760	429,644	463,404
50. Democracia	....	80,228	80,228
51. Diana	31,496	113,893	145,389
52. Domeyko (Antofagasta)	365,562	1,222,286	1,587,848
53. Elena (ex-Rosario de Negreiros)	....	....	....
54 Empresa (Toco)	270,185	1,027,902	1,298,087
55. Enriqueta	....	....	....
56. Esmeralda	23,167	75,479	98,646
57. Esperanza (Taltal)	65,340	258,910	324,250
58. Eugenia (Aguas Blancas).....	190,659	931,429	1,122,088
59. Felisa	....	205,182	205,182
60. Filomena (Antofagasta)	114,499	664,204	778,703
61. Flor de Chile (Taltal)........	76,580	322,134	398,714
62. Florencia (Antofagasta)	....	....	....
63. Francisco Puelma (Antofagasta)	279,985	1,241,454	1,521,439
64. Galicia (ex-Cataluna)	....	178,626	178,626
65. Ghyzela (Taltal)	152,423	321,943	474,366
66. Gloria	115,481	291,213	406,694
67. Grutas (Toco)	130,856	647,103	777,959
68. Hervatska	97,354	137,025	234,379
69. Higinio Astoreca (Antofagasta)	....	78,816	78,816
70. Huascar (v. Reducto).........	....	....	....
71. Iberia (Toco)	129,233	370,078	499,311
72. Jazpampa (v. Paccha)........	....	....	....
73. Josefina	86,100	232,086	318,186
74. Jose Santos Ossa (Antofagasta)	201,407	1,277,442	1,478,849
75. Keryma	28,474	180,080	208,554
Forward	6,379,990	31,151,783	37,531,773

Name of The Oficina.	Stock.	Production in one year.	Total.
Forward	6,379,990	31,151,783	37,531,773
76. La Americana (Aguas Blancas)	203	....	203
77. La Granja	178,640	498,946	677,586
78. La Palma	219,226	619,690	838,916
79. La Patria	....	....	....
80. La Perla	....	....	....
81. Lagunas	178,720	507,341	686,061
82. Lastenia (Antofagasta)	225,754	807,748	1,033,502
83. Lautaro (Taltal)	50,277	314,167	364,444
84. Leonor (Antofagasta)	....	....	....
85. Lilita (Taltal)	97,389	213,135	310,524
86. Los Pirineos (v. Providencia)..	....	....	....
87. Luisis (Antofagasta)	184,101	675,166	859,267
88. Mapocho	66,749	227,309	294,058
89. Maria (Antofagasta)	301,884	1,185,003	1,486,887
90 Maria Teresa (Aguas Blancas)	....	....	....
91. Maroussia	73,746	180,312	254,058
92. Mercedes	....	173,148	173,148
93. Miraflores (Taltal)	....	....	....
94. Moreno (Taltal)	236,025	673,811	909,836
95. North Lagunas	155,445	428,097	583,542
96. Oriente (Aguas Blancas)	94,334	268,547	362,881
97. Paccha y Jazpampa...........	118,236	521,173	639,409
98. Pampa Rica (Aguas Blancas)..	1,000	65,000	66,000
99. Pan de Azucar................	100,573	434,583	535,156
100. Paposo y Limenita............	....	....	....
101. Pena Chica	123,627	524,828	648,455
102. Pepita (Aguas Blancas)......	....	....	....
103. Peregrina (Toco)	273,199	344,813	618,012
104. Perseverancia (Antofagasta)...	....	11,000	11,000
105. Peruana	....	....	....
106. Petrolina (Aguas Blancas)....	14,880	194,388	209,268
107. Pissis (Antofagasta)	317,464	1,190,197	1,507,661
108. Porvenir	106,287	281,321	387,608
109. Primitiva	68,645	392,479	461,124
110. Progreso	54,520	212,870	267,390
111. Prosperidad (Toco)	338,550	1,367,748	1,706,298
112. Providencia y Los Pirineos....	19,441	222,268	241,709
113. Puntilla de Huara............	123,224	384,965	508,189
114. Puntunchara	95,929	427,087	523,016
115. Ramirez	178,344	621,268	799,612
116. Recuerdo	35,713	25,793	61,506
117. Reducto y Huascar...........	35,402	327,598	363,000
Forward	10,447,517	45,473,582	55,921,099

Name of The Oficina.	Stock.	Production in one year.	Total.
Forward	10,447,517	45,473,582	55,921,099
118. Restauracion	1,000	18,140	19,140
119. Resurreccion (ex-Iquique)	43,249	111,612	154,861
120. Rica Aventura (Toco)	186,944	778,509	965,453
121. Riviera (Antofagasta)	....	....	....
122. Rosario de Huara............	194,889	601,230	796,119
123. Rosario (Aguas Blancas)......	....	364,791	364,791
124. Sacramento	87,355	310,625	397,980
125. Salinitas (Taltal)	126,441	498,377	624,818
126. San Antonio	75,524	294,574	370,098
127. San Donato	64,955	323,340	388,295
128. San Enrique	....	....	....
129. San Francisco	26,817	115,562	142,379
130. San Gregoria (Ags. Blancas)..	....	....	....
131. San Jorge	26,890	209,989	236,879
132. San Jose	75,502	410,728	486,230
133. San Lorenzo	132,341	261,638	393,979
134. San Manuel	13,588	6,118	19,706
135. San Pablo	28,097	248,923	277,020
136. San Patricio	59,081	218,985	278,066
137. San Pedro	....	180,955	180,955
138. San Remigio	77,169	193,753	270,922
139. Santa Ana	....	....	....
140. Santa Catalina	100,313	305,640	405,953
141. Santa Catalina (Taltal)	....	....	....
142. Santa Clara	....	....	....
143. Santa Elena	43,685	82,740	126,425
144. Santa Fe (Toco)	222,106	652,666	874,772
145. Santa Isabel (Toco)	190,406	337,535	527,941
146. Santa Lucia	81,605	483,760	565,365
147. Santa Luisa (Taltal)	168,561	1,052,824	1,221,385
148. Santa Rita y Carolina........	88,820	390,605	479,425
149. Santa Rosa de Huara.........	22,108	277,498	299,606
150. Santiago	98,550	295,485	394,035
151. Sara	30,688	238,737	269,425
152. Savona (Antofagasta)	282,351	917,446	1,199,797
153. Sebastopol	....	....	....
154. Serena	....	....	....
155. Slavonia	....	....	....
156. South Lagunas	146,918	547,153	694,071
157. Tarapaca	11,457	132,258	143,715
158. Transito	103,124	451,083	554,207
159. Tres Marias	66,946	312,689	379,635
Forward	13,324,997	57,099,550	70,424,547

Name of The Oficina.	Stock.	Production in one year.	Total.
Forward	13,324,997	57,099,550	70,424,547
160. Tricolor (Taltal)	56,180	161,694	217,874
161. Trinidad	....	....	....
162. Union	75,675	183,531	259,206
163. Valparaiso	79,613	325,597	405,210
164. Valparaiso (Ags. Blancas)	....	....	....
165. Victoria (ex-Sloga)	27,989	151,453	179,442
166. Virginia	130,857	298,132	428,989
167. Vis	....	....	....
	13,695,311	58,219,957	71,915,268

This table corresponds to the Nitrate year 1912–1913.

TELLS OF CHILE'S NITRATE.

The most important subject discussed during the day was that of the nitrate industry. A very able paper on this subject was read by Enrique Cuevas, counselor of the Chilean Embassy. He gave a brief history of the Chilean nitrate fields, and described at length their character and composition, as well as the methods of extracting and treating the material. He emphasized the fact that those deposits are practically inexhaustible, and that they probably will continue for several centuries to produce as much as they are doing today.

DISCUSSION BY SEÑOR CUEVAS

Of His Paper Read at the Pan-American Scientific Congress.

The development of the industry for the fixation of nitrogen from the air is, on the one hand, slow, and on the other, requires great capital. So far, experience has shown that the financial results are much inferior to those expected. The production of nitrogen from the air falls far short of reaching the figures before estimated. Owing to these circumstances, the saltpeter from Chile (nitrate of soda), and the sulphate of ammonia are still the arbiters for the price of nitrogen. Chilean nitrate is taxed with a rather heavy export duty, which may be reduced or abolished by Chile, a circumstance which offers a real danger to the industry of atmospheric nitrogen, because, the reduction of the cost of Chilean nitrate being possible, there is no safe basis from which to calculate the financial results of an industry so far uncertain. This danger has no doubt been considered, inasmuch as the promoters of this business, already established, feeling the necessity of obtaining more capital to save that invested, and in order to convince European capitalists of the necessity of devoting more money to this industry, informed them that the Chilean nitrate was very nearly exhausted.

In the paper which I presented to the Second Pan-American Scientific Congress, I stated that there is

sufficient nitrate in Chile to supply the needs of the world for at least three hundred years. This figure I have given as a sure one, for if I were to give one not so certain or so probable, I would surely have been obliged to name a much longer period of years. So if, from the technical point of view, the extraction of nitrogen from the air is a resolved problem, from the practical and financial point of view its resolution is unknown.

The United States has no doubt enormous hydraulic powers that may be devoted to the extraction of nitrogen from the air, but there is only one objection to it, in my opinion a very strong objection,— namely, that this power applied to any other industry will give much greater profits.

From the agricultural point of view, which is no doubt the most interesting one for this country, it is necessary to keep in mind the fact that the physical conditions of the products obtained by the different systems already known for the extraction of nitrogen from the air do not answer the agricultural requirements; in the first place, because the products so obtained are difficult to handle, and further, because they cannot conveniently be distributed over the soil. As soon as the receptacle is opened, the contents must be used; otherwise they are spoiled by the absorption of humidity from the air. The losses resulting from this condition, as well as the cost of the receptacle, make atmospheric nitrogen more expensive. Chilean nitrate does not offer any of these disadvantages. The article may be used at any moment in the required quantity, and may be distributed in the soil in mathematically exact proportions, while that which remains unused does not spoil. The receptacle, moreover, is only a common sack.

So far, the atmospheric nitrogen industry has not given to the farmers the cheap fertilizer promised.

At the session of the Scientific Congress at which I read my paper on the "Nitrate Industry in Chile," it was said that the United States was paying Chile more than $17,000,000 every year for the nitrate it consumes. This, in my opinion, is no argument, for if every one of the different countries of the world should begin to take account of the millions of dollars that they pay yearly to

the industries of the United States, and should begin to invest the capital necessary to produce such articles at home, in order to leave in their own countries the money now paid to the United States, all the foundations upon which the commercial systems of the world rest would give way.

It was also said that in case of an international conflict, in which the United States became involved, this country would find itself in a difficult position to obtain the nitrate necessary for the manufacture of explosives.

The remedy for this situation is at hand. Why does not the United States buy great quantities of nitrate and store an amount sufficient to meet the necessities of a long campaign? The article does not suffer from storage, and the quantity required is not so very great. Germany who holds such a strong position in the present European conflict was thus enabled by her importing nitrate from Chile in enormous excess quantities up to the very day when war was declared to meet with ease her great crisis.

So the United States, with its enormous coast line on the two oceans, possessing, moreover, the key of the Panama Canal, will certainly be able at any moment to import nitrate from Chile, even in the midst of a conflict. Therefore I do not understand the urgency of investing capital in an industry of such uncertain financial results, although I do understand perfectly well the patriotic spirit that moves those who are advocating this idea.

Before concluding, lest some one think that the previous arguments are partial, it may not be out of place to say to those who are not familiar with the nitrate industry in Chile, and the fiscal interest in the same, that:

The financial systems of the different countries adjust themselves to the requirements of those countries. Chile, for instance, sends to the United States its mineral products without receiving any profit from them. The exportation of iron and copper is not taxed in any form. Millions of tons of these minerals are coming and will come from Chile to the United States, where they are manufactured, and constitute afterwards one of the greatest sources of income to this country. This is due

to the fact that the export duty on nitrate is sufficient to procure for the Chilean Treasury the money necessary for its expenditures. It is only logical and anyone will understand, that if that income should be reduced by the reduction of the export duty on nitrate, following limitation of the exportation of nitrate, an equilibrium would be established by fixing new export duties on other substances. And certainly these duties would be imposed first of all on those minerals that are exported in the greatest quantities — iron and copper. So the previous arguments do not indicate partiality on my part.